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ISOLATING THE EFFECTS OF ACTIVE RESPONDING IN COMPUTER-BASED INSTRUCTION

Roger M. Tudor
Westfield State College

This experiment evaluated the effects of requiring overt answer construction in computer-based programmed instruction using an alternating treatments design. Four college students worked through an instructional program that alternated between presenting frames with blanks requiring overt responses and complete frames without blanks. All students produced a higher percentage of correct posttest answers corresponding to program segments that required overt answer construction.

DESCRIPTORS: academic behavior, programmed instruction, computer-based instruction, instructional design, alternating treatments design

The increased use of computers in education has created a resurgence of interest in programmed instruction as a method for establishing new repertoires. In well-designed programmed instruction, the student is required to respond actively. Tudor and Bostow (1991) found that students who overtly constructed and typed their responses to computer-presented frame blanks answered more posttest questions correctly, on average, than those who simply read through frames without blanks. Because this was a between-groups study, averaging across subjects within groups made it more difficult to identify functional relationships and limits the generality of the results. The present experiment replicates and extends the results of Tudor and Bostow by using an alternating treatments design to isolate more carefully the effects of active responding in programmed instruction. By alternating the presentation of frames with blanks requiring an overt response and complete frames without blanks to each student, the independent contribution of these two presentation formats was evaluated.

METHOD: Four undergraduates worked through a computer program that presented operant conditioning and instructional design principles. From a 315-frame program originally used by Tudor and Bostow (1991), 189 frames were selected. All instructional stimuli were presented on IBM® PS2, Model 30 computers that included color monitors, disk drives, and keyboards.

The present analysis used an alternating treatments design similar to one described by Sindelar, Rosenberg, and Wilson (1985). The program was divided into four equal segments, each with an independent (nonoverlapping content) set of instructional frames. These segments alternated between having students type responses to frame blanks and read complete frames without blanks. When responses were typed the computer presented the words "correct" or "incorrect," followed by the next frame with the correct answer. These conditions are directly comparable to stimuli previously presented to subjects of Groups 1 and 5 by Tudor and Bostow (1991).

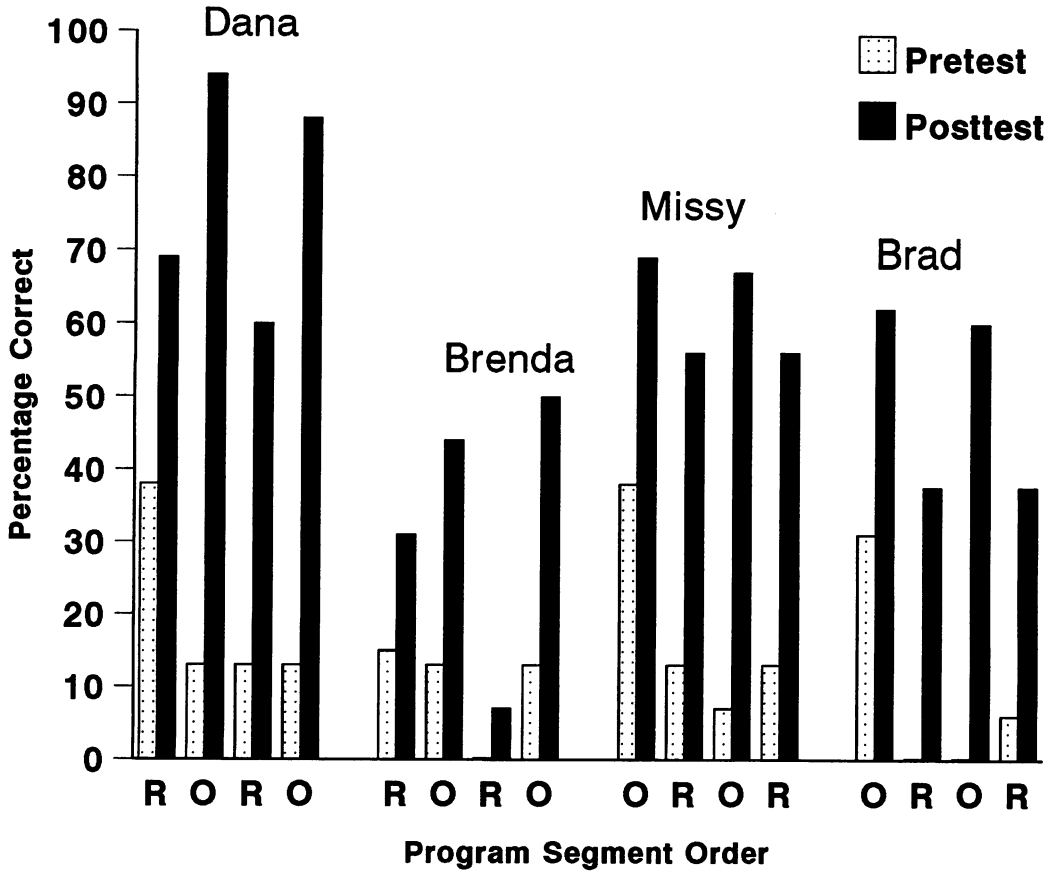
Two students were randomly assigned to work through program segments in the following order: (a) overt responding to blanks, (b) reading frames without blanks, (c) overt responding to blanks, and (d) reading frames without blanks (ORORO). To control for the effects of sequence and any possible changes in program difficulty, 2 additional students were assigned to work through the same program in the opposite order: (a) reading frames without blanks, (b) overt responding to blanks, (c) reading frames without blanks, and (d) overt responding to blanks (RORO).

One day before the experiment, students supplied written answers to a 60-item fill-in-the-blank pretest. These questions corresponded to important program-presented concepts and principles. As students subsequently worked through overt response segments, the number of correct and incorrect responses was recorded, as was the time to complete each segment. Synonyms were not accepted as correct responses. Immediately after finishing the program, each student completed a posttest that was identical to the pretest.

RESULTS AND DISCUSSION: Each student's responses on the pretest and posttest were evaluated and then partitioned into one of four program segments. The numbers of posttest questions corresponding to these program segments were 13, 16, 15, and 16, respectively. As shown in the figure, all students produced a higher percentage of correct posttest answers when they overtly constructed answers to frame blanks compared to reading frames without blanks. The added contribution of overt answer construction above that of simply reading completed frames was (from left to right for each student in the figure) 26.5%, 28%, 12%, and 23.5%, an overall average difference of 22.5%. The benefits of overt answer construction did not appear to vary with the presentation order of program segments. The results of a paired t test showed overt answer construction to be superior to reading completed frames, $t(3) = 2.37$, $p = .05$. The effect size corresponding to this t value is .65. When working through program segments that required overt answer construction, students averaged 66.9% correct in typing responses. Typing responses into the computer increased the length of time needed to complete these program segments by an average of 10 min. Prolonged exposure to these instructional stimuli may have contributed to higher posttest scores. In addition, the effects of the pretest in each student's immediate history may have also influenced these results in unknown ways.

These results replicate and extend those of Tudor and Bostow (1991). First, the instructional effects of overt answer construction were reproduced in all students. Active responding appears to be functionally related to greater achievement. Second, the counterbalanced design permitted the isolation of the effects of active responding. Other single-subject research designs are not as easily adapted to evaluate the cumulative response-strengthening effects of programmed instruction. A number of variables related to the effectiveness of instructional programs and computer-based instruction can now be reexamined with increased resolving power.

Additional problems do remain to be solved, however. For example, answers to test questions may not adequately summarize all that is learned in programmed instruction. They are a superficial and rare form of verbal behavior in which responses are evoked out of order and topography is overemphasized. Tudor and Bostow (1991) have previously reported that students could better apply their



"knowledge" (as measured by a subsequent application task) after completing an interactive program. Unfortunately, the present research did not evaluate generalization, because separate application tasks could not be designed for individual program segments. Evaluating the effects of generalization will remain a challenge for future research.

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Address correspondence and reprint requests to Roger M. Tudor, Department of Psychology, Westfield State College, Westfield, Massachusetts 01086. Received November 21, 1994; final acceptance May 28, 1995; Action Editor, Donald Hantula.